Particle Trapping

김성조

Contents

1. Cavity cooling of a single atom
2. Light forces in the ray optics regime
3. Force of the gradient trap on spheres
4. Objective

1. Cavity cooling of a single atom

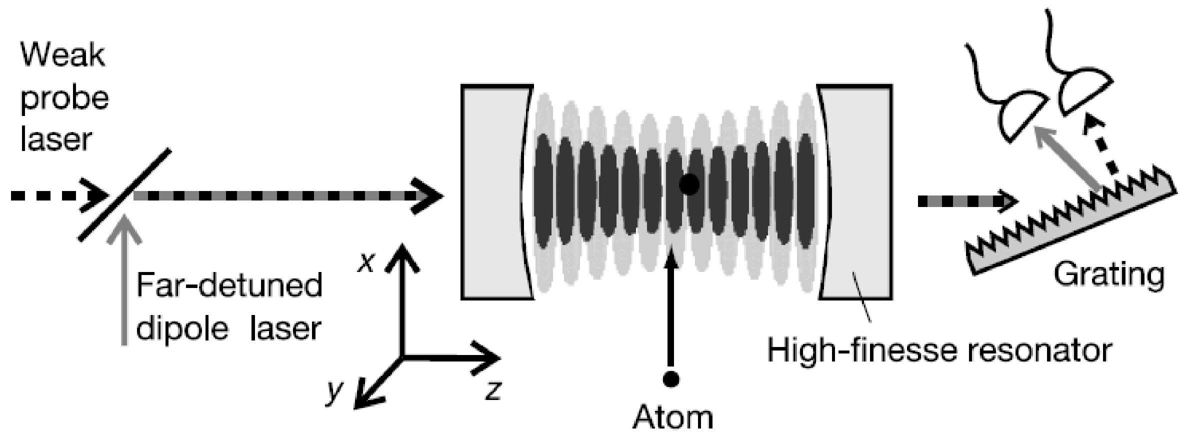
2. Light forces in the ray optics regime

3. Force of the gradient trap on spheres

4. Objective

5.

6.



Anti-node→Node

Atom의 KE는 낮아지고, cavity 내의 field energy를 증가시키고, 이는 빛의 blue-shift를 발생시킨다.

Node→Anti-node

많이 발생하지 않는다.

Node에서 Atom의 localiztion이 나타난다.

1. Cavity cooling of a single atom

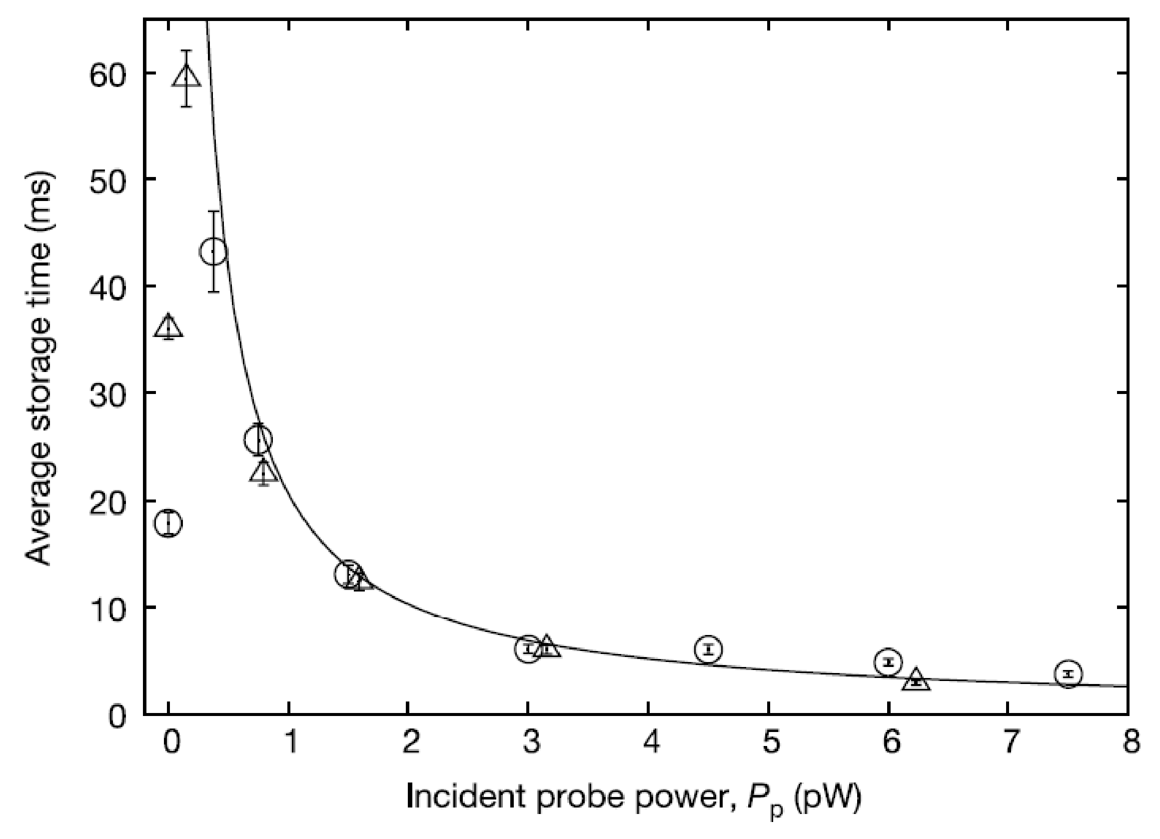
2. Light forces in the ray optics regime

3. Force of the gradient trap on spheres

4. Objective

5.

6.



Trapping laser wavelength(λ) & Sphere particle diameter(D)

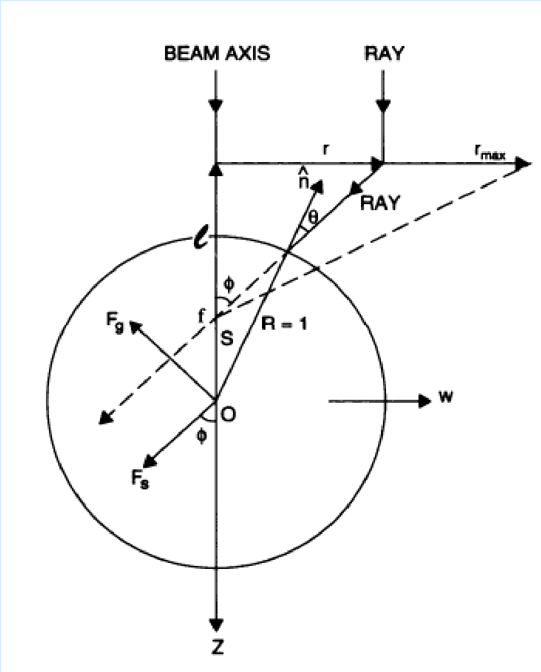
A. Layleigh regime,(the particle acts as a simple dipole)
$\lambda \geq D$

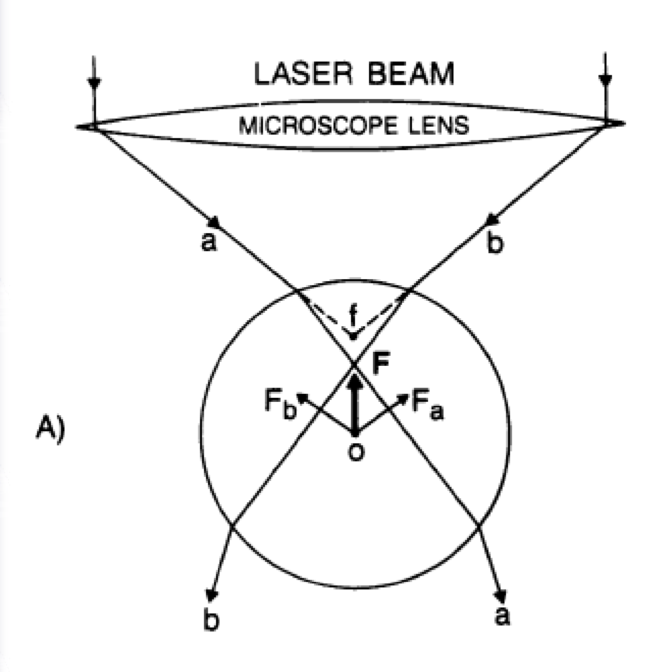
B. Optics ray
$D \gg \lambda$

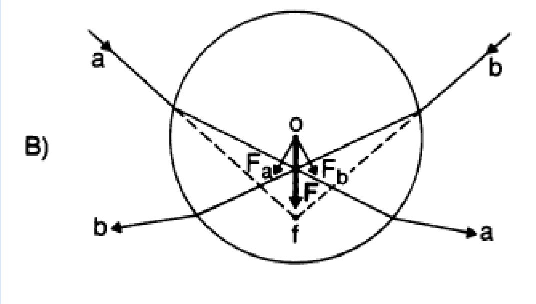
Force components

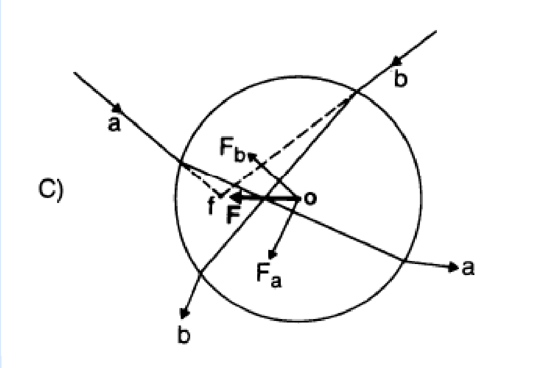
A. Scattering force,
(Incident beam) F_s

B. Gradient force,
(Intensity gradient of the Light) F_g







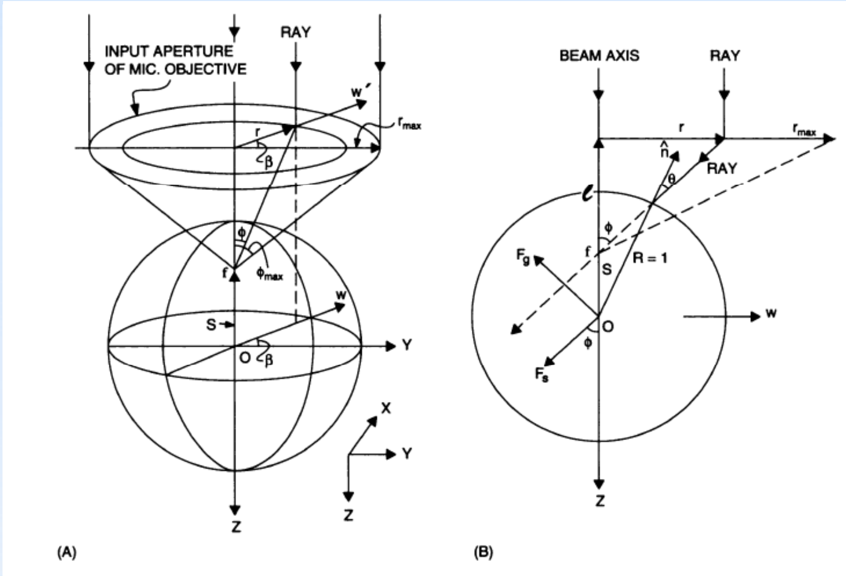


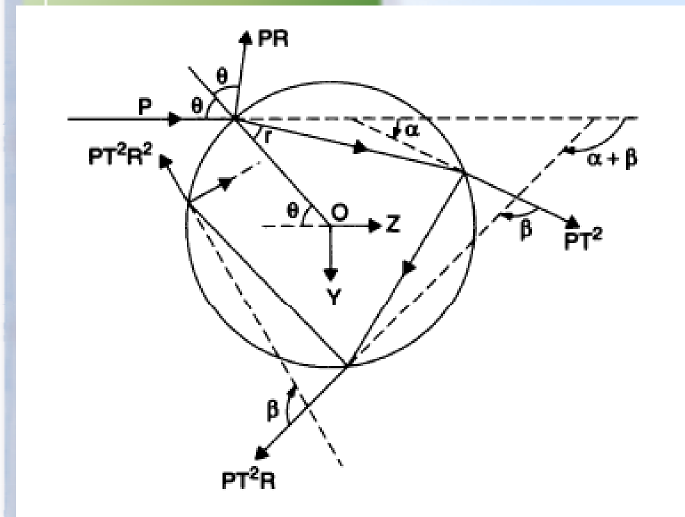
구 입자에 빛이 입사하는 상황은 위의 세 가지 경우로 요약할 수 있다.

1. Cavity cooling of a single atom

2. Light forces in the ray optics regime

3. Force of the gradient trap on spheres





P → PR, PT

PT → PT^2, PTR

PTR → PT^2R, PTR^2

PTR^2 → PT^2R^2, PTR^3

PTR^3 → PT^2R^3, PTR^4

1. Cavity cooling of a single atom

2. Light forces in the ray optics regime

3. Force of the gradient trap on spheres

4. Objective

5.

6.

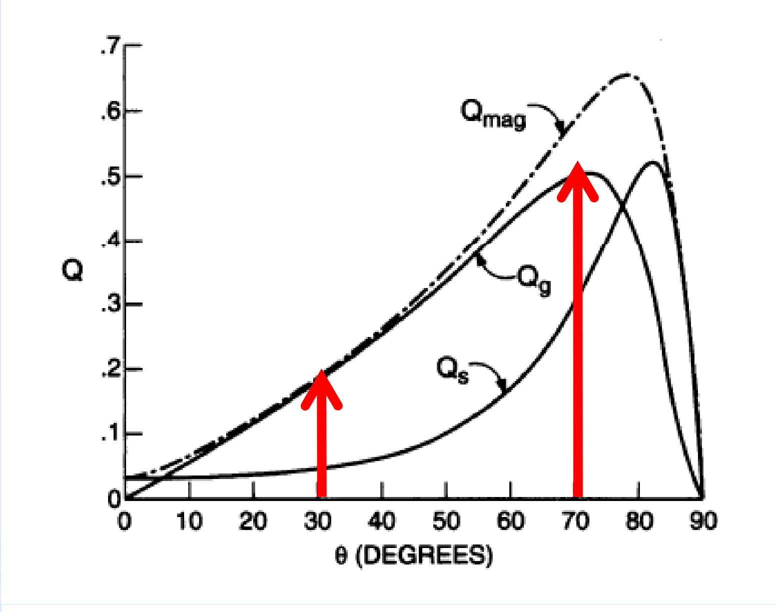
$$F_s = F_Z = \frac{n_1 P}{c}\{1 + R\cos 2\theta - \frac{T^2[\cos(2\theta - 2r) + R\cos 2\theta]}{1 + R^2 + 2R\cos 2r}\}$$

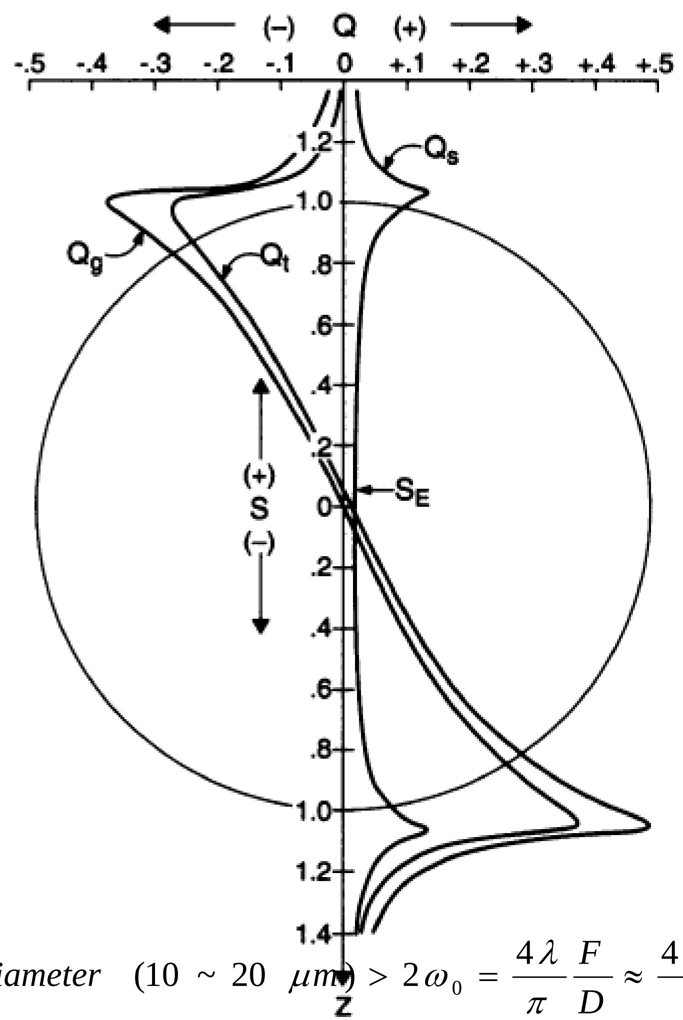
$$F_g = F_Y = \frac{n_1 P}{c}\{R\sin 2\theta - \frac{T^2[\sin(2\theta - 2r) + R\sin 2\theta]}{1 + R^2 + 2R\cos 2r}\}$$

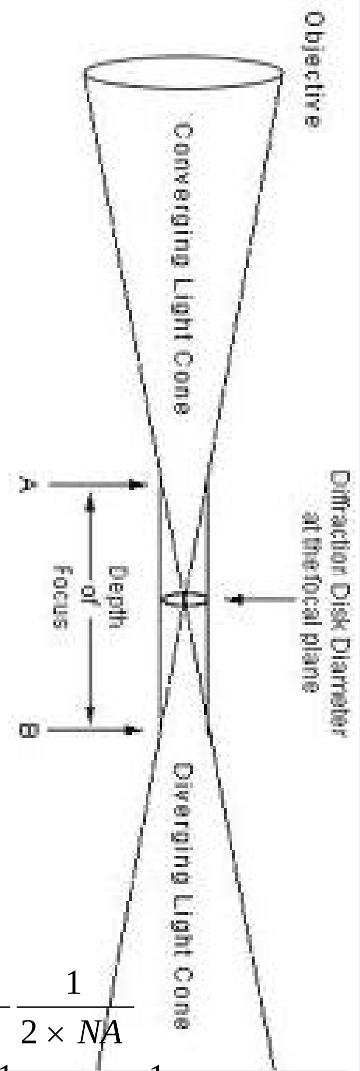
$$F_{mag} = (F_s^2 + F_g^2)^{1/2}$$

$$F = G n_1 P c^{-1}$$

$$G_{mag} = (G_s^2 + G_g^2)^{1/2}$$







$$Diameter \quad (10 \sim 20 \quad \mu m) > 2\omega_0 = \frac{4\lambda}{\pi}\frac{F}{D} \approx \frac{4\times 1\,\mu m}{3.14}\frac{1}{2\times NA}$$

$$Diameter \quad (10 \sim 20 \quad \mu m) > DOF = \frac{8\lambda}{\pi}\left(\frac{F}{D}\right)^3 \approx \frac{8\times 1\,\mu m}{3.14}\left(\frac{1}{2\times NA}\right)^3$$

1. Cavity cooling of a single atom

2. Light forces in the ray optics regime

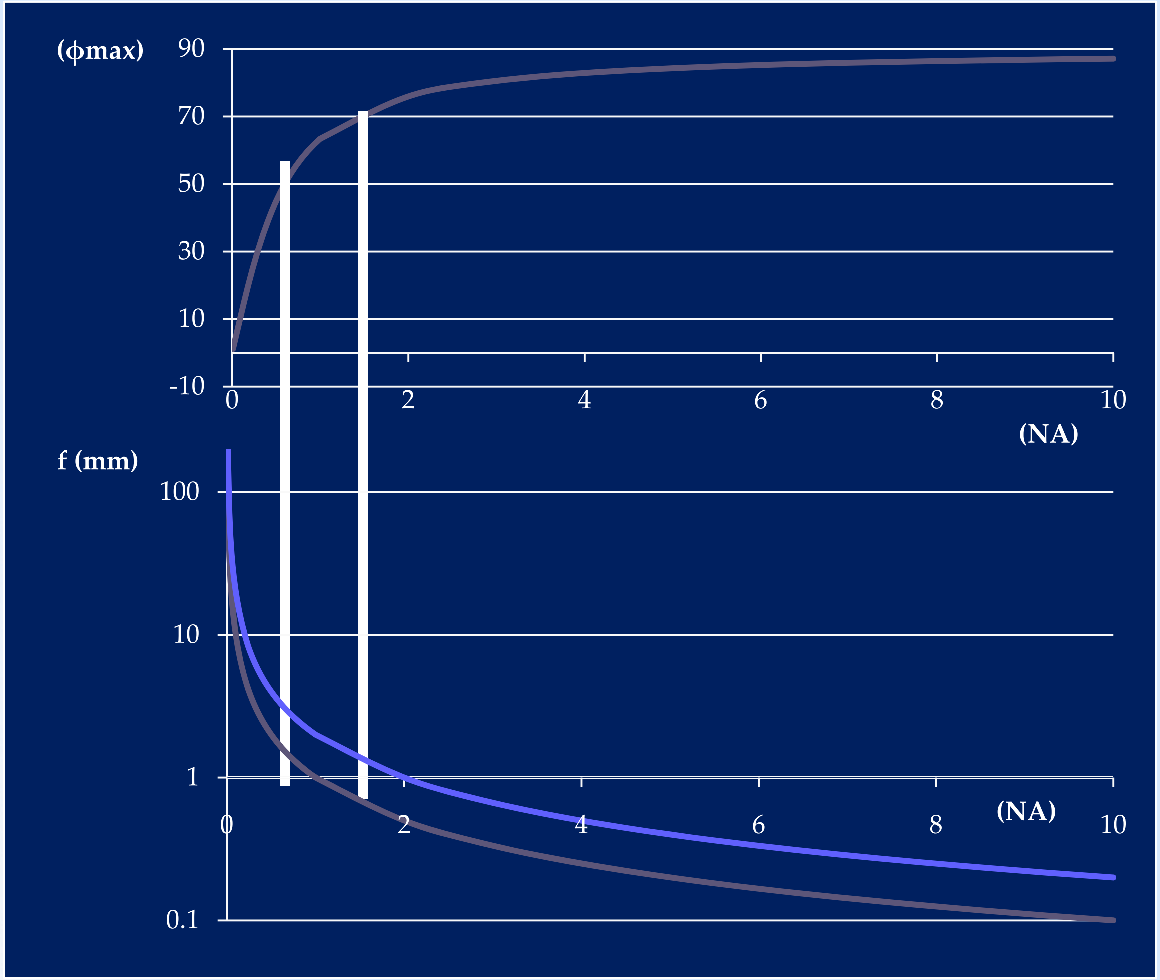
3. Force of the gradient trap on spheres

4. Objective

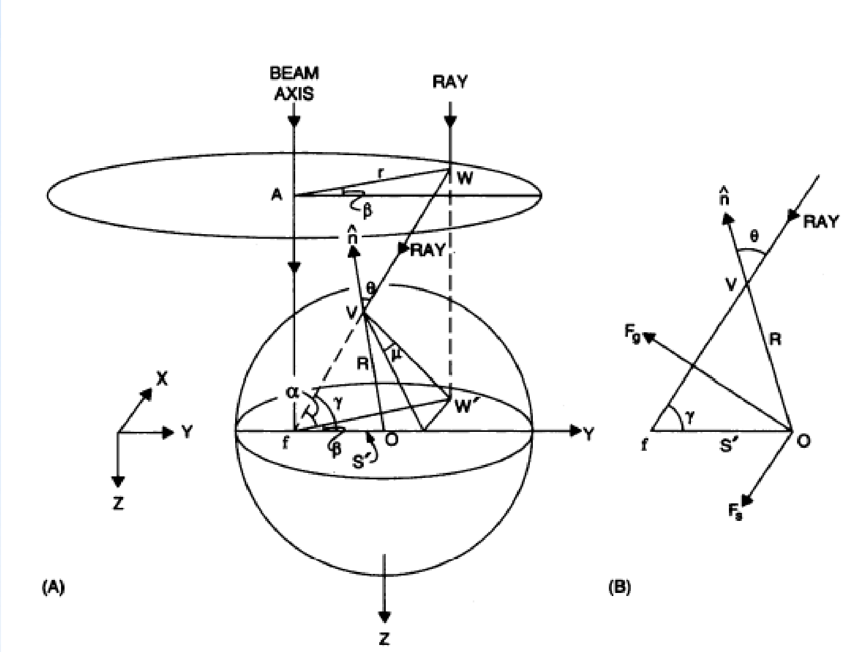
5.

6.

NA and ϕ_{max}



1. Cavity cooling of a single atom
2. Light forces in the ray optics regime
3. Force of the gradient trap on spheres
4. **Objective**
5.
6.



빔의 직경을 최대한 크게 한다.(~4mm)

모든 조건은 Gs의 값이 큰 영역에 있어야 한다.

빔 직경 한계에 의한 조건의 한계